IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 19, Issue 6 Ser.4 (June. 2020), PP 01-05
www.iosrjournals.org

Recent Diagnostic Aids in Endodontics

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Abstract: *In the modern world, there are so many recent advances in diagnosis in conservative dentistry Endodontics. It is enhanced by newer technologies. The style of this improvement is targeted towards increasing the objectivity sensitivity and reproducibility of the pulp tests while decreasing the patient's discomfort. Methods like Pulse Oximetry, Laser Doppler Flowmetry, Ultrasound Doppler, Dual Wavelength Spectroscopy, Photoplethysmography are being developed and evolved to get adapted to the current clinical setting which may be of great use to the modern endodontist. These new methods fulfill the necessity of choosing the best tools for a good diagnosis. The aim of this review therefore was to assess the utility of some devices and techniques utilized in endodontic therapy to make the correct diagnosis*

Keywords*; endodontic diagnosis, recent advances, magnification*

Date of Submission: 22-05-2020 Date of Acceptance: 09-06-2020

I. Introduction

Diagnosis plays a very important role in formulating correct treatment plan for any disease process. "Diagnosis is an art and science of identifying the disease by using scientific knowledge to determine the cause of the disease".[1]In dentistry, the diagnosis is the process where the data is obtained from questioning and examining the patient. The goal of diagnosis is to assess the condition of oral cavity and identify the cause of discomfort or disease.

There are several methods used by the clinician for the diagnosis of dental disease, but the most common method is conventional method which includes visual, tactile and radiographic examinations. Although, the above mentioned methods serve as an important diagnostic aids for diagnosis, but also have some limitations.[2]To overcome these shortcomings, there have been many recent diagnostic aids have been introduced which helps in detection of diseases in its initial stage. There are many recent adjunct aids used to sharpened the image and also to improve the illumination. The human naked eyes are capable of distinguishing fine details, but there is no match for what can be accomplished by improved illumination and magnification. The microscope and other forms of magnification fulfill that need, especially to perform the endodontic procedures. Enhanced magnification and illumination improved the visualization of the intricate and complex anatomy of root canal system.[3]

Today's innovative and high-tech optical system can deliver amazing depth of field and wide field of view which helps the dentist to view complete oral cavity, for e.g. endoscope and orascope. The rod lens in endoscope and fiber optic in orascope increased the magnification, which is helpful in detection of complex or internal morphology of tooth.[4]

There have been development of some alternative non-invasive detection method which is based on fluorescence phenomenon where the light is absorbed in specific wavelength, the light absorption and remission is different in normal and affected part of hard tissues .So, by the help of Dignodent,Fibre optic transillumination etc. the, extent of lesion can easily differentiatedThe clinical and radiographic examination does not confirm the diagnosis. Confirmatory diagnosis mainly based on histo-pathological findings on cellular or molecular level. Although we have many adjunct or supplementary aids for the diagnosis, but more researches has been made to formulate the accurate diagnosis with minimal invasive diagnostic tools.

II. Recent Aids In Dentistry

Digital Radiography:

The first system that was introduced in digital radiography in dentistry was radio-visiography by Trophy in France 1987.Digital radiography is a method of reproducing a radiographic image using a technology sensor of solid-state, which are broken into electronic pieces, and presented and stored as an image using a computer. A digital image is a collection of brighter and darker areas same as that of a film based image, but the

nature of the digital image is totally different from that of film.[5]There are two advanced technologies that create digital images without an analog precursor. Direct digital images and Semi direct digital images.
Direct digital images are acquired using a solid-state sensor. The solid-state sensors are based on charge coupled device (CCD) and complementary metal oxide semiconductor (CMOS) and CMOS-active pixel sensor (CMOS-APS) based chips. Semi-direct digital images are obtained using a phosphor plate system.

Digital Subtraction Radiography (DSR) :
DSR is a more advanced image analysis tool.The procedure is based on the principle that two digital radiographic images obtained under different time intervals, with the same projection geometry, are spatially and densitometrically aligned using specific software.

- Assess the healing process of periapical lesion
- Improvement in detection of dental and maxillofacial lesion
- Also used for evaluation of the progression, arrest, or regression of carious lesion.
- Helpful in temporo-mandibular joint especially with panaromics.

Tuned aperture computed tomography:
Tuned aperture computed tomography (TACT) is a simple, faster and noninvasive method for reconstructing tomographic images **.**Helpful in detection of radicular fracture or mandibular fracture**,** Assess the caries and extra canal more accurately than conventional techniques, Helpful in detection of degree of radiopacity of restorative material overlying or adjacent to it.[6]

Magnetic Resonance imaging (MRI)
MRI is non-invasive method for the detection internal structure and certain aspects of human body. It employs radiofrequency radiation in the presence of magnetic field in order to produce high quality cross-sectional images of the body in any plane.[7] it Helpful in detection of extent of carious lesions,Assess the status of pulpal tissue whether reversible and irreversible pulpitis,For the diagnosis and evaluation of benign and malignant tumors of jaw,For the assessment of intracranial lesions involving particular posterior cranial fossa, the piturity and spinal cord., For noninvasive evaluation of the integrity and position of articular disc within TMJ[8]

Ultrasonic Imaging:
Ultrasonic imaging was introduced for detecting the early carious lesions on the smooth surfaces. The demineralization of enamel is assessed by "ultrasound pulse echo technique".It has been seen that there is a definite relation between the mineral content of lesion and relative echo amplitude changes.[27]The ultrasonic probe is used which sends longitudinal waves to the surface of the tooth and also serve as function of receiving the waves.

- Detect very early carious lesion.
- Determine the change in mineral content of lesion by relative echo amplitude change.
- It also used to guide fine-needle aspiration biopsy in the neck with the advantage of low cost, ease of usage and radiation safety.[10]

Cone beam computed tomography-
Cone beam computed tomography is recent technology initially developed for angiography in 1982 and subsequently applied to maxillofacial imaging.It uses divergent or cone shaped source of ionizing radiations and 2D area detector fixed on area gantry to acquire multiple sequential projection images in one complete scan.

- Helpful in detection of vertical root fractures.
- Helpful in detection of root morphology, number of root, accessory canals Detect the separated instrument into canal.
- Helpful in endodontic surgery planning and identification of root canal not seen in 2 D images.[11]

Ultrasound:
Ultrasound (US) is a non-invasive, inexpensive and painless imaging method. Unlike X-rays, it does not cause harmful ionizing radiation. Ultra sound can be used for both hard and soft tissue detection.[12]

- Detect the pulpal blood flow in vital tooth.
- Healing of periapical lesion can also be detect.

Optical coherence tomography*:*
Optical coherence tomography is a new diagnostic imaging technology that was first introduced in 1991. Optical coherence is an attractive noninvasive imaging technique for obtaining high-resolution images.

Optical coherence tomography combines the principles of an ultrasound with the imaging performance of a microscope, it also produces images from back-scattered sound echoes.

- Helpful in evaluation of dental restoration.
- Detection of caries.
- Evaluation of periodontal disease.
- Helpful in acquiring the image of incipient carious lesion as well as advanced lesion for evaluating their demineralization.

Microcomputed tomography:

The X-ray micro-computed tomography (micro- CT) was recently developed.It is a noninvasive, non-destructive method for obtaining two- and three-dimensional images.

- Analyses the internal anatomy of teeth.
- It also detect the instrument of root canal, root canal filling materials.
- Also evaluate the physical and biological properties of materials.

***Computer assisted densitometric images analysis (CADIA*)**:

In CADIA video camera measures the light transmitted through radiographs and the signals from camera is converted into gray scale image.Computed assisted densitometeric image analysis is computer program based on densitometric interpretion of digitalised radiographic images. It is most commonly used for periapical and panoramic images. Due to inexpensive, non-invasive diagnostic method. An image quality (i.e. resolution) changes according to increasing or decreasing pixel/voxel size. It is used in bone remodeling after flap surgery, peri-implant tissue variations after flap surgery, the healing process in the furcation area after regenerative procedures.

FiberOptic Transillumination :

Fiber optic transillumination (FOTI) is easy, fast inexpensive method of imaging teeth in the presence of multiple scattering and also have been introduced to improve early detection of carious lesion..It is based on the changes in the scattering and absorption phenomenon of light photons that increase the contrast between sound and diseased enamel.

Digital Imaging Fiber Optic Transillumination

DIFOTI is a method in which digital image processing for quantitative diagnosis in dentistry.It is based on light propagation just below the tooth surface and can be used to determine the lesion depth .It uses fiber optic transillumination of safe visible light to image the tooth.

Pulse Oximetery:

The term 'oximetry' is defined as the determination of the percentage of oxygen saturation of the circulating arterial blood and readily differentiates between vital and non vital teeth**.**A pulse oximeter works on the principle that uses a photo electric diode that transmits light in two wave lengths (red-660nm).

- Effective and objective method to evaluate the pulp vitality.
- Useful in cases of traumatic injuries where the blood supply remain intact but nerve supply is damaged.
- Easy to reproduce the pulp tissues

Laser doppler flowmtery:

Laser Doppler Flowmetry (LDF) which is a noninvasive, objective, painless, semi-quantitative method, has been shown to be reliable for measuring pulpal blood flow. Pettersson and Oberg[13]in 1991 used Laser Doppler flowmetry to check the activity of pulp in intact and traumatized teeth..This method based on Doppler principle in which low power light from monochromatic laser beam of known wavelength along fiber optic capable is directed to the tooth surface, where light passes along the direction of enamel prisms and dentinal tubules of pulp.

Teraherz*:*

Teraherz pulse imaging(TPI) is relatively new imaging modality in dental field.Imaging of very smaller enamel lesion without ionizing radiation would be represent significant breakthrough,for dentistry Teraherz pulse imaging(TPI) technology has already been applied to measurment to dimeralizedand carious enamel performing comparison with microradiography

Multiphoton imaging*:*
Its a noninvasive method of acqisation of quantifable measurment of mineral and collect infromation from caries lesion upto 500µm.

Infra-Red thermography:
This technique has described as method for determining the presence or absence of disease.Thermal radiation energy travels in the form of waves.It is possible to measure changes in thermal energy when fluids is lost by lesion through evaportion.

- Detection of infra alveolar nerve deficit
- Helpful in detection of TMJ disorder
- Monitoring endodontic treatment

Photoplethesmography:

- It is a method for assessing the change in volume and has been applied to the investigation of arterial disease because the volume of limb or organ exhibit transient cardiac change over cardiac cycles.

Magnification:
Magnification is an essential requisite in current precision based endodontic practice. Initially, devices that enhanced vision were restricted to magnification loupes. More recently, the use of dental operating microscope has gained momentum and its endodontic diagnosis:

- Locating hidden canal obstructed by calcifications.
- Detection of cracks and fracture.

Recent advance in magnification are listed below:
Endoscope:
The term endoscopy is derived from the Greek language and is literally translated as endon (within) and skopion (to see), hence the meaning, to see within. Early endoscopist such as Hippocrates in 377 BC used primitive tube-like instruments for endoscopy.[14]The Modular endoscope system being based on modern technology microendoscopes is used in small channel organs (salivary gland ductal system, tear canals) and is designed to enable the practitioner to work inside the root canal with magnification and instrument access.

Use of Dental Endoscope:
a. Diagnosis
b. Enhances visualization
c. Transillumination
d. Apical surgery:
e. Endoscopic Observation during Endodontic treatment:

Orascope*:*
The recently introduced flexible fiber optic orascope is recommended for intracanal visualization, has a 0.8mm tip diameter,0 degree lens and working portion that is 15mm in length. The term orascopy describes the use of either the rigid rod-lens endoscope or the flexible orascope in the oral cavity.[15]

Dental loupes
Dental loupes have been the most common form of magnification used in apical surgery. Loupes are essentially two monocular microscope with lenses mounted side by side and angled inward to focus on an object. Magnifying sometimes are called "loupes".

Operating Microscope:
Microscope was introduced in endodontics in early 1990s.It gives higher magnification, illumination and superior optical properties. Clinician can easily change the working magnification.The dental operating microscope employ Galilean optics. In Galilean optics the optical paths are parallel and focused at infinity. This reduces the need to have the eye coverage to focus and thereby reduce eye strain and fatigue.

III. Conclusion

These newer techniques gives more accurate and clear diagnosis about status of the dental disease. With the development of advanced system in traditional radiography three dimensional imaging technique introduced which gives a detail information about the internal structure of dental hard tissues in all the three planes.Based on scientific knowledge many more recent diagnostic modalities are under research, few of these

system are in their infancy and many are based solely in laboratories, however such technologies may prove useful in future.

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Dr.Divya Pandey, et. al. "Recent Diagnostic Aids in Endodontics." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 19(6), 2020, pp. 01-05.